

INDOOR AIR QUALITY REASSESSMENT

**Memorial Middle School
502 Cabot Street
Beverly, MA 01915**



Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
October 2004

Background/Introduction

At the request of Heidi Zimmerman, Administrator of Operations and Finance, Beverly Public Schools (BPS), the Massachusetts Department of Public Health (MDPH), Center for Environmental Health's (CEH), Bureau of Environmental Health Assessment (BEHA) conducted an indoor air quality reassessment at the Memorial Middle School (MMS), 502 Cabot Street, Beverly, Massachusetts. A visit to conduct an indoor air quality assessment was made previously. The purpose of the June 3, 2003 visit was to examine environmental conditions in the crawlspace. A report was released September 2003 detailing conditions found in the building at the time of the assessment (MDPH, 2003). The purpose of the May 2004 visit was to examine possible mold growth in classroom 152 as well as to describe the remediation efforts undertaken by the BPS to improve indoor air quality within the building.

On May 4, 2004, a visit to conduct a reassessment was made to the MMS by Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Ron Bouchard, Director of Facilities, BPS, and, for portions of the reassessment, Donna Jenko, MMS Principal and Ms. Zimmerman.

BPS Actions on MDPH Recommendations

As mentioned, BEHA staff had previously visited the building and issued a report with recommendations to improve indoor air quality (MDPH, 2003). A summary of actions taken on previous recommendations is included as Appendix A.

Methods

BEHA staff performed a visual inspection of building materials for water damage and/or microbial growth. Moisture content of water damaged building materials was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The MMS houses approximately 450 students in sixth to eighth grades and approximately 50 staff members. Tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million (ppm) in seven of thirty areas surveyed, indicating adequate ventilation in the majority of areas. As discussed in Appendix A, several univents are scheduled for repair/replacement. These univents were deactivated or inoperable at the time of the reassessment.

The Massachusetts Building Code requires that each room have minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 ppm. Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please refer to [Appendix B](#).

Temperature readings in occupied areas were measured in a range of 69° F to 78° F, which were very close to the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of

building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity readings in occupied areas of the building ranged from 26 to 37 percent, which were below the BEHA recommended comfort range. The relative humidity in the crawlspace measured 62 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously mentioned, the focus of this assessment was to examine potential moisture/mold growth conditions in classroom 152. In order for building materials to support mold growth, a source of moisture is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Building materials with increased moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of the location of materials with increased moisture levels can also provide clues concerning the source of water supporting mold growth.

In an effort to ascertain moisture content of building materials in this area, readings were taken in materials that would most likely be impacted by water penetration. Building materials tested included ceiling tiles, wall plaster and wood near exterior walls/windows. Moisture readings from similar building materials located on non-exterior walls were measured for comparison. The Delmhorst probe is equipped with three lights as visual aids to determine

moisture level. Readings that activate the green light indicate a sufficiently dry or low moisture level, those that activate the yellow light indicate borderline conditions and those that activate the red light indicate elevated moisture content. No elevated moisture readings were measured during the assessment. It is also important to note that the reassessment occurred after several days of heavy rain. No active leaks were reported, nor was standing water or current water damage observed in classroom 152.

Elevated moisture content was detected in ceiling tiles in classroom 145. At the time of the assessment, BEHA staff recommended removing these tiles, as well as those in the cafeteria. Active leaks persist in these areas (Appendix A). The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Other Concerns

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM_{2.5}) can produce immediate, acute health effects upon exposure. To determine whether combustion products were

present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM_{2.5}.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address airborne pollutants and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter. As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it is present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon

monoxide concentrations were non-detectable (ND). Carbon monoxide levels measured in the school were also ND (Table 1).

As previously mentioned, the US EPA also established NAAQS for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) in a 24-hour average (US EPA, 2000a). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, the US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standards requires outdoor air particle levels be maintained below 65 $\mu\text{g}/\text{m}^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 25 $\mu\text{g}/\text{m}^3$ at the time of the assessment. PM2.5 levels measured indoors ranged from 1 to 22 $\mu\text{g}/\text{m}^3$, which were below outdoor levels (Table 1). Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC concentrations were also ND (Table 1).

Please note, TVOC air measurements reported are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While TVOC levels were ND, materials containing VOCs were present in the school. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Lastly, the amount of materials stored inside some classrooms is also of note. Items were observed on windowsills, tabletops, counters and bookcases. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and the respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Conclusions/Recommendations

BPS officials, working in conjunction with private contractors, faculty members and school maintenance staff, have improved indoor environmental conditions in the building by implementing the majority of BEHA's previous recommendations. As indicated in Appendix A, several of these recommendations need further action. In view of the findings at the time of this visit, the following additional recommendations are made to further improve indoor air quality:

1. Continue to implement previous BEHA recommendations (MDPH, 2003).
2. Open windows to supplement airflow and improve comfort/airflow in classrooms lacking operable mechanical ventilation. Care should be taken to ensure windows are properly closed at night and weekends during the heating season to avoid the freezing of pipes and potential flooding.
3. Remove water damaged ceiling tiles in cafeteria and in room 145. Continue to drain active leaks until roof repairs are made. Examine the areas above and around these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
4. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
5. Consider adopting, the US EPA (2000b) document, Tools for Schools, in order to provide self assessment and maintain a good indoor air quality environment at your building. The document can be downloaded from the Internet at <http://www.epa.gov/iaq/schools/index.html>.
6. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these

materials are located on the MDPH's website:

<http://www.state.ma.us/dph/beh/iaq/iaqhoFtme.htm>.

References

- ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.
- ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989
- BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.
- MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.
- MDPH. 2003. Indoor Air Quality Assessment. Memorial Middle School, Beverly, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.
- OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.
- Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.
- SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0
- US EPA. 2000a. National Ambient Air Quality Standards (NAAQS). . US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC.
<http://www.epa.gov/air/criteria.html>.
- US EPA. 2000b. Tools for Schools. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-K-95-001, Second Edition.
<http://www.epa.gov/iaq/schools/tools4s2.html>
- US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001.
http://www.epa.gov/iaq/molds/mold_remediation.html

Beverly Memorial Middle School
502 Cabot Street, Beverly MA 01915

Table 1

Indoor Air Results
May 5, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbo n Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background (Outdoors)	65	21	406	ND	ND	25	-	-	-	-	Clear skies, sunshine SW winds 10-15 mph
152	70	30	590	ND	ND	12	9		Y Univent	Y Wall	DEM, clutter; 9 occupants present 5 minutes, room occupied by 8 individuals 30 minutes., Low moisture content wooden windowsills/CTs/wall plaster/wooden wall trim, no active leaks (roof, windows, plumbing) or current WD
15	72	34	770	ND	ND	14	23	Y	N	N	DEM
37	74	37	976	ND	ND	11	16	Y	Y Univent	Y Wall	
ESL	72	32	655	ND	ND	14	0	Y	Y Off Univent	Y Wall	DEM; exhaust blocked by furniture
30	71	32	569	ND	ND	13	0	Y	Y Univent	Y Wall	DEM

ppm = parts per million

µg/m3 = micrograms per cubic meter

AD = air deodorizer

AP = air purifier

aqua. = aquarium

AT = ajar ceiling tile

BD = backdraft

CD = chalk dust

CP = ceiling plaster

CT = ceiling tile

DEM = dry erase materials

design = proximity to door

FC = food container

G = gravity

GW = gypsum wallboard

M = mechanical

MT = missing ceiling tile

NC = non-carpeted

ND = non detect

PC = photocopier

PF = personal fan

plug-in = plug-in air freshener

PS = pencil shavings

sci. chem. = science chemicals

TB = tennis balls

terra. = terrarium

UF = upholstered furniture

WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1-1

Beverly Memorial Middle School
502 Cabot Street, Beverly MA 01915

Table 1

Indoor Air Results
May 5, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
44	69	30	606	ND	ND	11	18	Y			Bread mold experiment on UV
Technology	72	32	692	ND	ND	11	22	Y	Y Off Univent	Y	UV inoperable, needs motor replacement
Gym	71	27	460	ND	ND	12	20		Y Off Ceiling	Y Wall	AHUS Deactivated by wall panel
47	71	31	431	ND	ND	11	0	Y	Y Off Univent	Y	DEM; hallway door open; deactivated due to noise
Art	72	31	614	ND	ND	13	24	Y	Y Univent	Y	DEM; supply blocked by clutter
Crawlspace	71	62	462	ND	ND	13	-	--	N	Y Wall	
Cafeteria	73	36	1095	ND	ND	22	~160	Y	Y Univent	Y Wall	Hallway door open; 1 of 3 UV on, active leak in café – water caught by barrels; active leak in kitchen; exhaust blocked by soda machine

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Table 1-2

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Indoor Air Results
May 5, 2004

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbo n Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
32	74	32	623	ND	ND	10	0	Y	Y Univent	Y	1 OF 2 uv “on”; exhaust blocked by clutter
145	72	28	559	ND	ND	16	11	Y	Y Univent	Y Wall	DEM; hallway door open; elevated moisture reading on CT (2), fresh stain in painted area; supply blocked by clutter
142	74	27	513	ND	ND	11	3	Y	Y Univent	Y Wall	Hallway door open
149	71	30	707	ND	ND	10	11	Y	Y Univent	Y Wall	DEM; supply blocked by furniture
157	74	29	741	ND	ND	11	20	Y	Y Off Univent	Y Wall	DEM; UV deactivated due to excessive heat
151	70	33	834	ND	ND	11	20	Y	Y Univent	Y Wall	DEM
155	71	30	642	ND	ND	11	16	Y	Y Univent	Y Wall	DEM; supply blocked by clutter, furniture

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									Supply	Exhaust	
Music Room	78	27	458	ND	ND	10	1	Y	Y Univent	Y Wall	Supply blocked by furniture
165	70	30	895	ND	ND	11	20	Y	Y Univent	Y Wall	Hallway door open; supply blocked by furniture
Nurse	71	29	580	ND	ND	12	3	Y	N	Y Wall	
217	76	29	812	ND	ND	13	17	Y	Y Off Univent	Y	Hallway door open
218	74	27	705	ND	ND	13	16	Y	Y Univent	Y Wall	CD
201	70	26	407	ND	ND	11	0	Y	Y Off Univent	Y Wall	DEM; hallway door open; occupants gone 5 minutes (lunch); supply blocked by clutter, plants
227	70	30	825	ND	ND	21	0	Y	Y Off Univent	Y Wall	DEM; occupants gone 7 min. (lunch); exhaust blocked by clutter

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									Supply	Exhaust	
219	74	28	568	ND	ND	14	0	Y	Y Univent	Y Wall	DEM, FF, cleaners; hallway door open; supply blocked by clutter
Library	73	28	706	ND	ND	15	30	Y	Y Off Univent		DEM, plants; hallway door open; 3 UV – all off
225	73	32	1084	ND	ND	20	0	Y	Y Off Univent	Y Wall	DEM, clutter; hallway door open; UV deactivated by occupant from power panel, occupants gone to lunch (2 min)
203	73	29	733	ND	ND	15	0	Y			Dem; hallway door open; UV noisy; occupants gone to lunch (5 min)

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Appendix A

Actions on MDPH Recommendations, Memorial Middle School, Beverly, MA

The following is a status report of action(s) taken on MDPH recommendations (**in bold**) based on reports from town officials, school maintenance staff, documents, photographs and MDPH, BEHA staff observations.

- 1. Seal utility holes and other potential pathways to eliminate pollutant paths of migration from the crawlspace to the first floor.**

Action: Utility holes were sealed.

- 2. Remove any mold-contaminated materials (e.g. stored items) in the basement. Remove and replace (if necessary) any water damaged/mold colonized building materials. This measure will remove actively growing mold colonies that may be present. Remove mold contaminated materials in a manner consistent with recommendations found in Mold Remediation in Schools and Commercial Buildings published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html**

Action: All mold-contaminated materials were removed and discarded.

- 3. Consult with an architect and or general contractor regarding the integrity of the building envelope, primarily concerning water penetration through walls and the foundation. Examine the feasibility of repointing brickwork.**

Appendix A

Action: Town officials reported in an action plan that services for a contractor to examine the building envelope were to be procured during the beginning of fiscal year 2005 (FY05).

- 4. Consult an HVAC engineering firm to determine the feasibility of providing mechanical exhaust ventilation to the crawlspace. The crawlspace should be placed under slight negative pressure to prevent air penetration into occupied spaces.**

Action: Mechanical ventilation was installed in the crawlspace to place the area under negative pressure (Picture A-1).

- 5. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.**

Action: The services of an HVAC engineering firm were secured to replace thermostats, repair steam traps and make repairs to the univent system to control airflow and temperature. The majority of the univents were repaired however due to budgetary constraints; the remainders are scheduled for repair during FY05.

- 6. Ensure all operable ventilation systems (supply and exhaust) throughout the building (e.g. gym, auditorium, classrooms) are operating continuously during periods of school occupancy, independent of thermostat control. To increase airflow in classrooms, set univent controls to “high”.**

Action: All ventilation systems that are operable are being operated in the building. Exceptions are the aforementioned univents and the gymnasium, which

Appendix A

has electrical problems. Univent controls were set to “high” and school staff are reportedly encouraged to regularly check the systems and report issues to administration officials.

- 7. Inspect exhaust motors and belts for proper function. Repair and replace as necessary.**

Action: All exhaust fans were functioning.

- 8. Remove all blockages from univents and exhaust vents to ensure adequate airflow.**

Action: Staff was instructed to keep univents and exhaust vents free of obstructions; however both univents and exhaust vents continued to be blocked in a number of areas (Pictures A2-A3).

- 9. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.**

Action: School department officials reported that the services of an HVAC engineering firm are to be procured in FY 05.

- 10. Remove plants from the wall/tarmac junction around the perimeter of the building. Seal the wall/tarmac junction with an appropriate sealer.**

Action: Plants were trimmed, which is an on-going process. Sealing of the tarmac had not occurred prior to the BEHA assessment; however school department officials reported that this activity was scheduled to take place within several weeks after the CEH May 2004 visit.

Appendix A

- 11. Ensure all roof leaks are repaired. Repair/replace missing/damaged flashing along roof. Replace any remaining water-stained ceiling tiles (for dropped ceilings). Examine the areas above and around these tiles for mold growth.**

Disinfect areas of water leaks with an appropriate antimicrobial.

Action: Roof repairs have been made with the exception of the kitchen/cafeteria, which continues to have active leaks (Picture A-4). At the time of the assessment the BSD was soliciting quotes to repair/replace the roof in this area.

- 12. For removal of tiles directly adhered to the ceiling, such removal would be considered a renovation activity that can release particulates and spores in particular, if the material is moldy. Replacement of ceiling tiles may involve glues that contain VOCs. In order to minimize occupant exposure, repairs should be done while the building is unoccupied.**

Action: Water damaged ceiling tiles were replaced in a number of areas. Some tiles appeared to have been sealed/painted (Picture A-5). The cafeteria, auditorium and some classrooms continued to have water damaged ceiling tiles. According to BSD officials, tile replacement for the auditorium is scheduled for FY 05.

- 13. Reinstall missing downspout in Picture 14 to direct rainwater away from the foundation.**

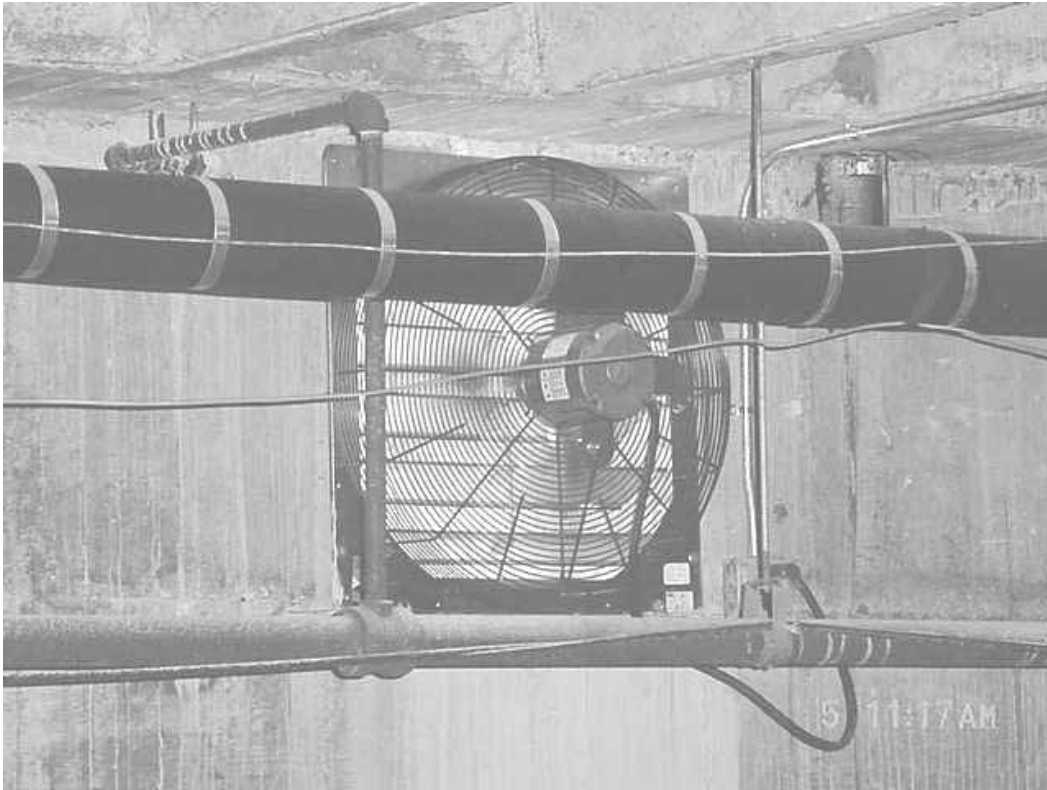
Action: The downspout was reinstalled (Picture A-6).

- 14. Consult with a roofing contractor to prevent water pooling on roof**

Action: See Action 11.

Appendix A

Picture A-1



Exhaust Fan Installed in Crawlspace

Appendix A

Picture A-2



Table in front of Univent Return Vent, Also Note Plants on Univent Air Diffuser

Appendix A

Picture A-3



Exhaust Vent “Cubby” Used for Storage of Recycle Bin

Appendix A

Picture A-4



Active Leaks being Drained into Garbage Barrels in Cafeteria

Appendix A

Picture A-5



Painted/Sealed Water Damaged Ceiling Tiles (First two Rows against Windows)

Appendix A

Picture A-6



Reattached Downspout